**NGO recommendations to support the Oil Sands Data Quality Action Plan and reporting under the National Pollutants Release Inventory**

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**Submitted to:** NPRI, Oil Sands Data Quality Sub Group

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## Executive Summary

This report provides commentary and recommendations toward advancing the Oil Sands Data Quality Action Plan. The recommendations collectively address advancing the purpose of the National Pollutant Release Inventory (NPRI) program as an important tool for identifying and monitoring pollution sources across Canada, providing transparency and informing Canadians about pollutant releases and transfers to the environment and contribute information to assess environmental performance. For the NPRI to an effective pollution registry tool, the report recommends that the NPRI program develop its reporting processes as a "mechanism" to support the 'right to a healthy environment' as articulated in the Canadian Government's Implementation Framework for the Right to A Healthy Environment, released in 2025. The Implementation Framework for the right to a healthy environment notes the importance of presenting NPRI data that makes it more relevant and accessible to populations who may be disproportionately impacted by a pollution source and easier for these populations to understand and use. The specific recommendations on the Oil Sands Data Quality Action Plan have been developed to support the NPRI program in achieving these ends. The recommendations rely on recent work of Environment Canada and Climate Change science on the emissions from the Oil Sands and the underreporting of these emissions by Industrial sector. The report recommends development of a conceptual model to ensure that all of the pollutants relevant in the oil sands processes are identified and reported and to improve transparency in data collected such that Canadians can be appropriately informed. The report recommends adapting the 'top-down' monitoring methods developed by Environment Canada to accurately capture the total emissions, and for comparison with bottom-up approaches to clearly identify sources and data gaps. The report highlights the approach for critical pollutants identified in the Oil Sands Data Quality Action Plan.

The report recommendations are:

**<u>Recommendation 1</u>: Considering the scope of workplan of the NPRI Oil Sands Data Quality Sub Group, the government (NPRI office) should undertake to review the NPRI**

**program, to assess changes that may be required to improve reporting of pollutants and accessibility to the pollution data. Improvements to the NPRI will improve the collection and accessibility to pollution data, that supports the NPRI as a 'mechanism' for the 2025 Implementation Framework for the Right to a Healthy Environment.**

**<u>Recommendation 2</u>: Develop a Conceptual Model of the Oil Sand Operations so the public can better understand the quantity of pollutants released to air, water (surface and groundwater), and soil and also off-site disposal and transfers from oil sand processes.**

**<u>Recommendation 2.1</u>: Use the new Conceptual Model to inform understanding and dialogue of chemicals that are not currently reported or captured by the NPRI, e.g., metals and organic molecules.**

**<u>Recommendation 2.2</u>: Use the Conceptual Model to inform the establishment of thresholds of chemical emissions for specific reporting requirements for individual substances or chemicals.**

**<u>Recommendation 3</u>: Collect NPRI information using "top-down" 'total carbon' emissions in order to inform understanding of total hydrocarbon emissions, and gaps, qualitative and quantitative, in emissions from oil sand processes.**

**<u>Recommendation 4:</u> Collect NPRI information using "top-down" naphthenic acid emissions in order to inform an understanding emissions, and gaps, in reporting of emissions from oil sand processes.**

**<u>Recommendation 5</u>: Require 'top-down' and 'bottom-up' monitoring for sulphur dioxide to develop an accurate understanding of emissions from oil sand processing.**

**<u>Recommendation 6</u>: Require oil sand facilities to report mobile NOx emissions.**

**<u>Recommendation 7</u>: Require Oil Sands facilities to validate emission predictions, monitoring locations and report emissions of Polycyclic Aromatic Hydrocarbons (PAHs), Ammonia, Mercury (Hg) and PM.**

## A) Introduction:

There was a lack of publicly accessible information about the impacts of most chemicals until the 1980s, when citizens around the world began demanding regulatory change to recognize their right to know about the health and environmental impacts of potentially harmful substances. Many governments in many countries developed publicly available inventories of the substances being released by certain polluters. One of these inventories is Canada's National Pollutant Release Inventory (NPRI, established in 1993). The results of Canada's first NPRI were released in 1994, and since this time, the NPRI has continued to evolve to reflect new scientific understandings, the development of new technology, and a changing regulatory landscape. These changes have always been made after public consultation, and, in the cases where the most substantial changes have been made, after input from a multistakeholder committee.

Under the Canadian Environmental Protection Act, 1999, mandatory reporting requirements under the NPRI required the owners and operators of applicable facilities to submit a variety of data to the NPRI. Reforms made to CEPA in 2023 that resulted in the recognition of the right to a healthy environment and the principle of environmental justice, have contributed to a shift in thinking about the range of public information available through the NPRI and the need to collect a broader scope of data and improve the accessibility of information about the chemicals regulated under CEPA.

The practical implications of these regulatory changes are still being figured out, so the NGO members of the NPRI Consultative Work Group have taken on the task of figuring out how to apply these new principles and legal responsibilities to expand existing data collection requirements for the NPRI. For example, Mining Watch Canada, a NPRI consultative work group member organization produced a paper in March 2025 that identified four areas of improvement that should be the focus of updates to the NPRI in order to improve access to environmental justice, discussed more in the next section.

This report continues this work and considers how to advance and improve the NPRI Action Plan for the Oil Sand through an environmental justice and equity lens. Overall, this report focuses on recommendations that could help the NPRI Oil Sand Group improve their modelling and data collection to better align with the new legal responsibilities and requirements that stem from the Implementation Framework for the Right to a Healthy Environment (GoC 2025) and other legal principles, such as the principle of environmental justice, recognized under CEPA.

The recommendations focus on the need for the development of a robust conceptual model to validate (a) all of the pollutants associated with the industrial processes, (b) that the data submitted to the NPRI accurately reflects the releases of pollutants from reporting facilities and (c) supports Canadians' understanding of data presented in the NPRI.

The recommendations specifically offer methods to be considered in support of comprehensive monitoring and accurate data reporting from the oil sands sector. Furthermore, the recommended approach will contribute to a better understanding of the full scope of potential

impacts/emissions that occur from oil sands processes. The report recommendations support the NPRI program as a starting point for Canadians to access a complete picture of emissions/discharges from the oil sands facilities. Overall, this report recognizes the need to move beyond existing approaches and techniques to reflect more equitable, unbiased approaches in the collection of NPRI data.

**B) The Right to a Healthy Environment, Environmental Justice, and the NPRI:**

In 2023, CEPA was amended to recognize that every individual in Canada has a right to a healthy environment. The Act now states that the Government of Canada has a duty to protect the right of every individual to a healthy environment subject to reasonable limits. The amended Act reflects new Administrative Duties including the right to a healthy environment, and also affirms the government's commitment to implementing the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), including free, prior and informed consent (FPIC).

As a result of these 2023 amendments, the government was required to develop an implementation framework to provide further insights into what the right to a healthy environment encompasses in a CEPA context and its practical impact on CEPA processes, including the collection and publication of data through the NPRI. The Implementation Framework for the Right to a Healthy Environment under the Canadian Environmental Protection Act, 1999 (Implementation Framework) was published in 2025 (GoC 2025).

The 2025 Oil Sands Air Emissions Data Quality Action Plan states that "In addition to these six approaches to improving data quality, a seventh approach to improve data accessibility will also be considered" (page ii). The ideal source for improving NPRI processes and data accessibility is the Implementation Framework (GoC 2025). The NPRI is included in the Framework for a Healthy Environment, (a) as a mechanism for Canadians to understand the proportion of pollution emissions in their area (b) support decisions that uphold the principle of environmental justice and (c) realize their right to a healthy environment.

With respect to the NPRI functioning as a mechanism, the Implementation Framework specifically articulates improving 'data accessibility', making data more relevant for populations and upholding the principle of environmental justice:

> *Exploring new approaches to make NPRI more relevant and accessible*
>
> *Building on the NPRI dashboard and the Reimagining pollution data project, explore approaches to improve the accessibility, use, representation, and meaning of NPRI data.*
>
> *This mechanism will explore ways of presenting NPRI data that makes it more relevant to populations who may be disproportionately impacted by a pollution source and easier for these populations to understand and use, helping to uphold the principle of environmental justice and supporting access to information. Having accessible data also helps CEPA decision makers to protect the right in risk assessment, risk management, and performance measurement by ensuring that decisions are informed by data that*

*includes which populations may be most impacted and evidence-based. (GoC, 2025, p. 48)*

NPRI program processes need to explore ways of presenting NPRI data that makes it easier for populations who may be disproportionately impacted by a pollution source to understand and use. The NGO working group recognizes that the NPRI is an important tool that can advance environmental justice and help uphold government responsibilities associated with the right to a healthy environment. However, to do so, the NPRI needs to be substantially strengthened with respect to its scope, reporting requirements and validation of data from reporters to inform communities and decision makers

The Implementation Framework also provides insights into the meaning and potential application of other important amendments made to CEPA in 2023, including the adoption of the principles of environmental justice, non-regression and intergenerational equity. Recognition of these principles provides additional support for the need to modernize the way data is collected and published under CEPA, with the NPRI being recognized as a mechanism in the implementation Framework for ensuring these improvements.

The Implementation Framework also explicitly recognizes Indigenous rights, “respect for section 35 rights, including the inherent right of self-government, and for the Government of Canada’s legislative and policy commitments to First Nations, Inuit, and Métis should inform decision-making under CEPA” and articulates the need to incorporate Indigenous knowledge to inform decisions. The Implementation Framework outlines processes for public participation and access to information, that support the principles and right to a healthy environment. In this respect the Implementation Framework provides guidance for the NPRI program to develop its processes.

The NGO working group wants to emphasize the earlier points that are reflected in the Implementation Framework and our recommendations that were included in a March 2025 paper, our colleague Jamie Kneen provided to improve access to environmental justice: scope, accessibility, responsiveness, and accountability. His recommendations are summarized below.

- **Scope:** The current limitations in NPRI reporting should be identified and acknowledged and work must be done to expand the scope of data collected and published.
- **Accessibility:** NPRI data should be made more accessible. NPRI data should be easily accessible in both physical and electronic format. Whether this means personal devices or physical locations at institutions like community centres and public libraries, NPRI data must be available in forms and formats that are useable and comprehensible without special training or extensive post-secondary education. Affected communities and individuals ultimately need to be able to build an understanding of the pathways and modes of risk that emerge from pollutant storage and releases, possible leaks and failures, etc.
- **Responsiveness**: Both data collection and its public presentation or access under CEPA should be adapted to meet the needs of vulnerable communities and groups and provide necessary inputs for analysis and decision-making processes. The NPRI needs

to have the capacity to be flexible and responsive to users across a range of needs, which requires interpreting its legislated mandate broadly to accommodate those needs.

- **Accountability:** The NPRI exists for the benefit of communities and individuals affected, or at risk of being affected, by toxic pollutants. The success of the NPRI ultimately hinges on the ability of affected communities and individuals to use it to inform and facilitate their understanding and decision-making with respect to those risks and effects. Mechanisms should be developed to evaluate the NPRI's effectiveness in this regard, including direct engagement with, and feedback from, affected communities and public-interest organisations.

**<u>Recommendation 1</u>: Considering the scope of workplan of the NPRI Oil Sands Data Quality Sub Group, the government (NPRI office) should undertake to review the NPRI program to align its function as a 'mechanism', which includes its reporting structure to assess changes that may be required to improve reporting of pollutants and accessibility to the pollution data. Improvements to the NPRI will improve the collection and accessibility to pollution data, that supports the NPRI as a 'mechanism' for the 2025 Implementation Framework for the Right to a Healthy Environment.**

## C) Key issues in Oil Sands Data Quality Action Play to advance reporting under the NPRI

The following section provides recommendations with supporting rationale to advance and improve the National Pollutant Release Inventory for the Oil Sand sector to provide the public with accurate and comprehensive pollution releases and transfer data from the sector.

**<u>Recommendation 2</u>: Develop a Conceptual Model of the Oil Sand Operations so the public can better understand the quality, quantity and health impacts associated with pollutants released to air, water (surface and groundwater), and soil and also off-site disposal and transfers from oil sand processes.**

The 2025 Oil Sands Air Emissions Data Quality Action Plan (Action Plan) does not consider the development of a detailed conceptual model. A detailed conceptual model would describe the Oil Sands processes, with sufficient rigour to (a) identify all the substances (see recommendation 1.1 below) (b)illustrate their formation and locations where they are released (c) identify their quantities and provide insight for relevant monitoring points, and (d) the development of meaningful thresholds for reporting (see recommendation 1.2 below). Many of the methods for calculating emissions in the NPRI (2026) guideline would necessitate a conceptual model, e.g., predictive emission monitoring and mass balance.

A conceptual model would clearly indicate releases to air, land, and water which includes surface water and groundwater. The NPRI figure from page 16 of the NPRI (2026) guideline does not articulate groundwater:


A conceptual model would clearly articulate the releases to the various media. Note, the NPRI Action Plan for the Oil Sands does not consider groundwater and focuses only on air.

The March 19, NPRI Oil Sands Data Quality Action Plan commentary supports the need to develop a conceptual model given the concerns with reported releases. The Action Plan notes:

> *NPRI related Oil Sands (OS) studies describe multiple discrepancies between observed/measured emissions and NPRI-reported emissions suggesting problems related to either NPRI reporting compliance, data accuracy/quality control, guidance for reporting, or estimations method availability.*
>
> *OS surface mining and processing facilities are large, complex, and unconventional industrial facilities that cannot be well represented by standard emissions-processing approaches for point sources.*

A conceptual model for each facility would address these concerns.

In addition, a conceptual model would help to alleviate a number of issues the Action Plan identifies for each of the following chemical substances:

- Ammonia: under-reporting of fugitive ammonia from tailings pond.
- Mercury: Inconsistencies in reported data between facilities and between NPRI reports and Alberta Annual Emissions Inventory Reporting (AEIR) Program reports.
- Naphthenic acids: NAFCs emissions to air from tailings ponds have been measured by researchers but not reported to NPRI by facilities yet
- PAHs: PAHs/PACs volatilizing from tailings ponds are underestimated, including some not listed on the NPRI.

- Reduced Sulfur compounds: Reduced sulphur compounds (RCSs) from tailings ponds are underestimated. Research observations were ~1.5-3x higher than reported to NPRI for H2S and TRS respectively
- Sulfur dioxide: Discrepancies between reported emissions and ambient SO2 levels satellite-based measurements
- Volatile Organic Carbon: 2013 & 2018 Aircraft-based measurement detected many VOCs that are not listed to the NPRI, total VOCs were significantly higher than what was reported to NPRI

An NPRI Oil Sands conceptual model for each facility would provide NPRI and Canadians with a means to identify and understand the magnitude of potential gaps in reporting that are identified in the Oil Sands Action Plan as a key issue. Conceptual models are typically developed to design and manage the facilities processes, including managing emergency situations. Therefore, it is reasonable to expect that companies have facility specific conceptual models to submit to the NPRI.

A conceptual model would also provide NPRI with an ability to meet its role as 'a starting point for identifying sources of pollution', as stated in the 2025-2027 NPRI guideline:

> ***NPRI information is a major starting point for identifying and monitoring sources of pollution in Canada****, and in developing indicators for the quality of our air, land and water. The NPRI helps determine if regulatory or other action is necessary to ensure reductions, and if so, the form that action should take. The NPRI provides Canadians with annual information on releases and transfers from industrial, institutional, commercial and other types of facilities in their communities. (NPRI, guideline for reporting emissions, 2025-2025, section 1, page 7).*

It would provide NPRI and Canadians a means of comparing different facilities to further identify potential gaps in reporting of emissions from any particular facility. In addition, a conceptual model would contribute to understanding potential health effects for facility releases, a key function of NPRI as a starting point and 'mechanism' for the Right to a Healthy Environment.

In addition, there are significant benefits to participants if a conceptual model is required. A conceptual model would help participants in NPRI processes gain an understanding of the source and rate of emissions. The conceptual model would facilitate explaining and understanding of any changes in the source or rate of emissions, either increasing or decreasing. Thus, in general a conceptual model would lead to more informed participation and decision-making in NPRI processes.

The conceptual model would facilitate the evaluation of pollution prevention plans that are required to be reported (NPRI guideline, 2026, section 4.5 p. 33):

> Facilities are required to report:

▪ Whether and why a pollution prevention (P2) plan was prepared in that reporting year;

▪ The name of the P2 notice, jurisdiction, or program for which the P2 plan is required;

▪ Information on P2 activities undertaken during the year; and

▪ The substances for which the P2 activities were undertaken.

**<u>Recommendation 2.1</u>: Use the new Conceptual Model to inform understanding and dialogue of chemicals that are not currently reported by the NPRI including all metals and organic molecules.**

A conceptual model would facilitate the NPRI and participants with identifying chemicals that should be considered for inclusion in NPRI reporting and that are currently not captured or even known to the NPRI and participants. He et al. 2024 identified a number of Volatile Organic Compounds (VOCs) released by Oil Sands facilities that are not currently captured.

With respect to VOCs, He et al. 2024 note “missing carbon”:

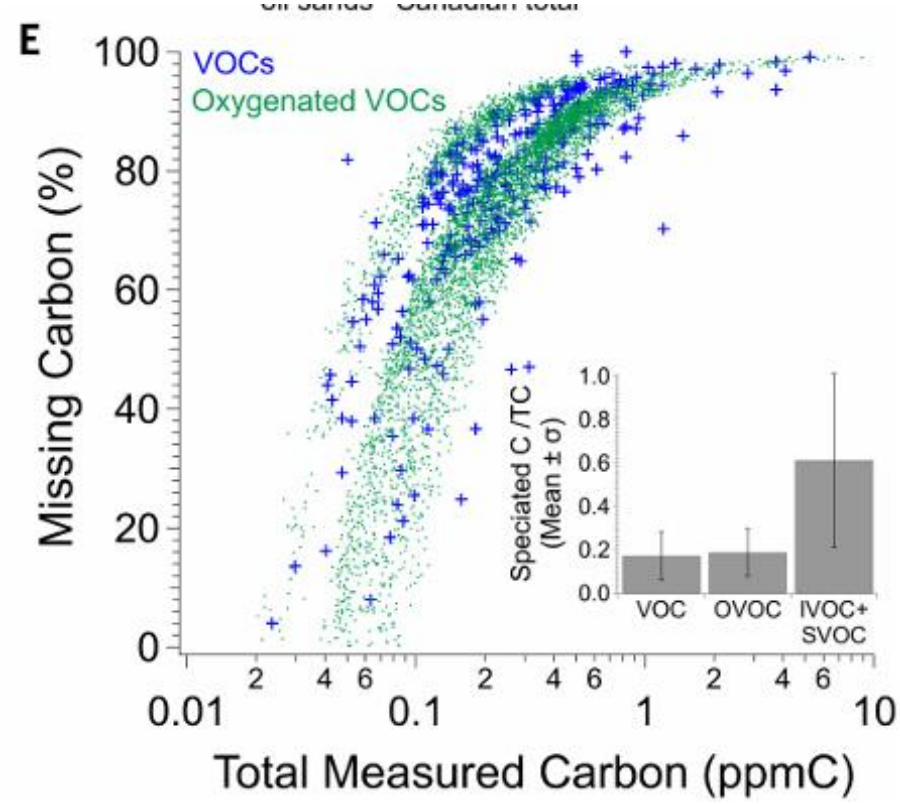



Fig 1 E. (E) Percentage of “missing” organic carbon relative to either VOC or OVOC measurements based on canister samples, PTR-ToF-MS, and iodide-CIMS. (Inset) Average contributions of VOCs, OVOCs, and I/SVOCs to total observed organic carbon measurements

in concentrated plumes (>0.35 ppmC), which represents the top 75th percentile of TC data. This is not in comparison with emissions inventories. For the purpose of comparing with the discrete speciated VOCs and OVOCs that are predominantly C10 and smaller, the IVOC+SVOC value in the inset is inclusive of C11 compounds.

A conceptual model would illustrate Oil Sands facility processes and the associated chemical reactions that result in the release of VOCs that are currently missing in NPRI reporting.

He et al. (2024) comment on the "missing carbon" and the insufficient "bottom-up" approach, i.e., the need for top-down monitoring of Oil Sands VOCs:

> **Measured VOCs only account for a fraction of total measured organic carbon** (fig. S1), **reflecting the need to report the full range of organic volatilities across Oil Sands** and other anthropogenic sectors. Even when including measurements of oxygenated VOCs (OVOCs) with two on-board high-resolution mass spectrometers [proton transfer reaction–time of flight mass spectrometry (PTR-ToF-MS) and iodide–chemical ionization mass spectrometry (iodide-CIMS)] (table S4), a substantial fraction of carbon remains "missing" relative to the total carbon observations (Fig. 1E). In this case, **"missing" indicates that the sum of speciated carbon is less than the total measured carbon**.
>
> At lower total carbon concentrations (background air), most of the observed total carbon was speciated. In **concentrated oil sands plumes with TC concentrations >0.35 ppm C, VOC and OVOC measurements were only responsible for 17 ± 11% and 19±11% of carbon**, respectively (**Fig. 1E**, inset).
>
> Conversely, the I/SVOCs observed in integrated low time-resolution adsorbent tube samples represented a greater fraction (61 ± 40%) (Fig. 1E and fig. S2), **highlighting the abundant contributions of I/SVOCs to total oil sand–related emissions and their insufficient bottom-up quantification in reported emissions** (table S3).

The Action Plan issue 8h, for VOCs says: "consider addition of total carbon". The results of He et. al. 2024 affirm that the addition of total carbon is necessary (see recommendation 2).

The Action Plan on particulate matter notes the issue that "NPRI does not currently require reporting of PM speciation, but this is needed for air quality modelling". Yang et al. (2023) showed that metals are broadly present in fine particulate matter emissions released from Oil Sands facilities. The following figure illustrates the variety of metals monitored off-site:

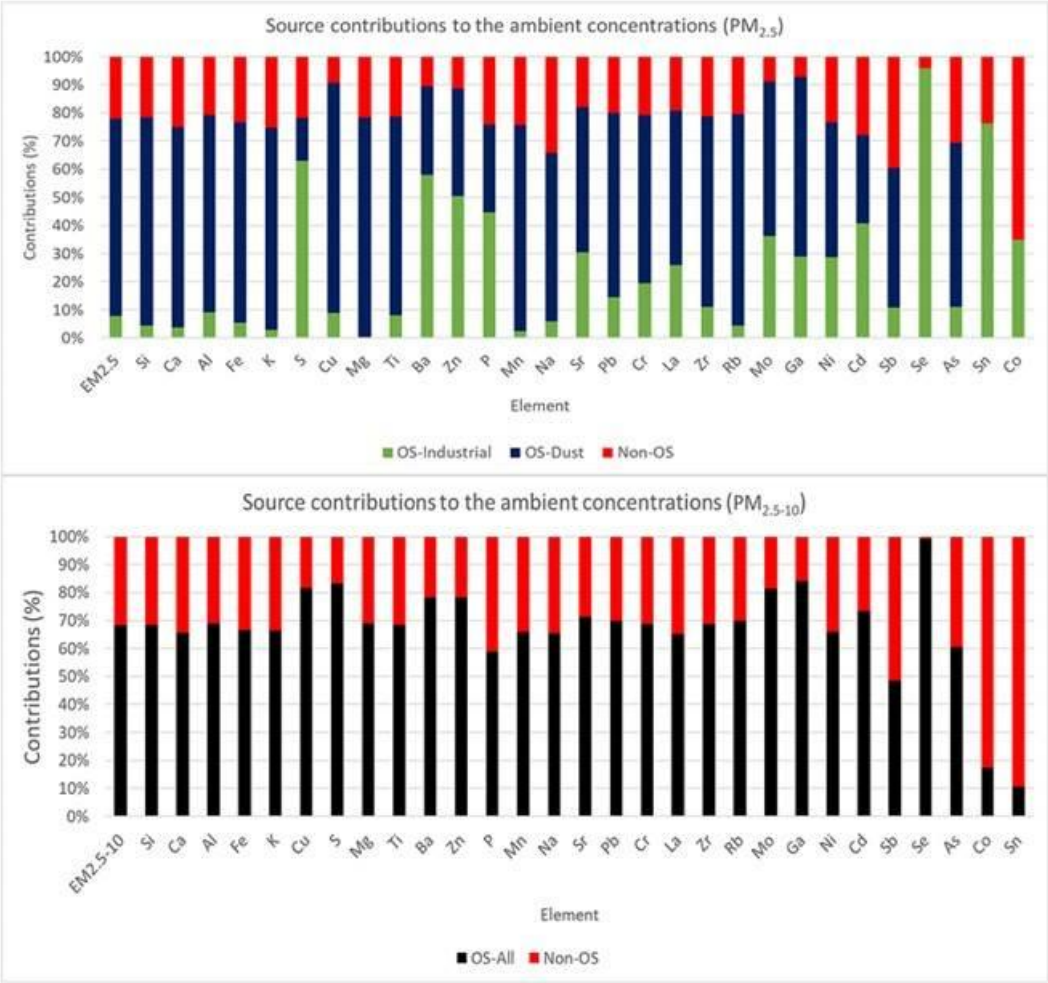



**Fig. 3.** Percentage contributions of the categorized emission source sectors to the ambient concentrations of the elements in $PM_{2.5}$ (upper panel) and $PM_{2.5-10}$ (lower panel). Elements are arranged from left to right in descending order according to their respective total concentrations ($CF_{full}$ and $CC_{full}$ in Tables 2-3).

The figure illustrates that PM is composed of a number of metals from the Oil Sands facilities. An adequately detailed conceptual model would illustrate the source of the metals released from Oil Sands facilities.

**<u>Recommendation 2.2</u>: Use the Conceptual Model to inform the establishment of thresholds of chemical emissions for specific reporting requirements for individual substances or chemicals.**

NPRI currently uses a threshold of a chemical substance for reporting criteria. Jackson and de Leon (2025) have written to NPRI that it is 'Time for Assessment of NPRI Thresholds' and outline a number of concerns with respect to thresholds for NPRI reporting, focusing on the needs of adjacent communities, their 'right to a healthy environment' and cumulative effects. Currently, communities adjacent to facilities may have no knowledge of the chemicals being released from facilities other than those that facilities determine meet the 'threshold' for NPRI reporting.

A conceptual model approach would address these concerns and bring transparency on facility processes, the chemicals involved and the potential releases of substances.

The 2026 NPRI reporting guideline provides some rationale but these do not specifically relate to facility processes. Using a conceptual model to validate thresholds, would enable NPRI and participants to develop an understanding of the processes and chemicals at facilities, and the NPRI reportable quantity of substances released from facilities. The conceptual model would serve to validate the thresholds for substances and their requirement for NPRI reporting. In this respect, a conceptual model would be beneficial in providing supporting rationale for the selection of thresholds.

At present, the NPRI (2026) guideline states:

- facility owners or operators must consider each year individually when determining if thresholds are met and if reporting is required (NPRI 2026, page 7).
- Once it has been determined that a facility meets the specific thresholds for an NPRI substance, the total quantities released, disposed of, or transferred must be reported. (NPRI 2026, p. 16).

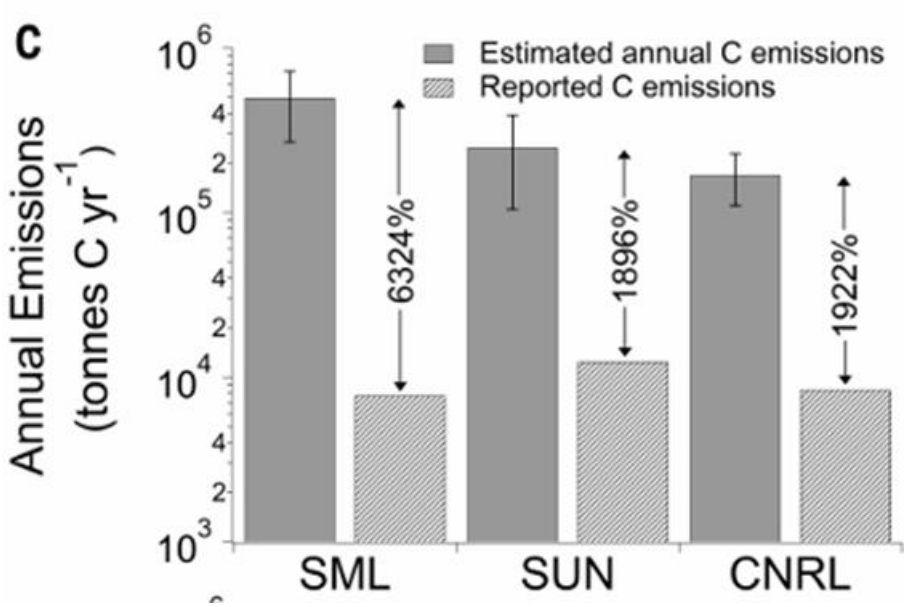
At present there is no means to understand how facility owners are conducting this analysis with specific reference to the process at their facilities. A conceptual model would serve to make this determination transparent.

**<u>Recommendation 3</u>: Collect NPRI information using "top-down" 'total carbon' emissions in order to inform understanding of total hydrocarbon emissions, and gaps, qualitative and quantitative, in emissions from Oil Sands processes.**

The Action Plan for VOCs says 8h: "consider addition of total carbon". In conjunction with developing a conceptual model, reporting "top-down" 'total carbon' emissions would help evaluate the gaps in emissions reporting.

The Action Plan (issue 8) addresses VOCs, and notes that Li et al. 2017, using a top-down approach with aircraft measurements in the summer of 2013, noted 20 individual VOCs and isomer groups that are not listed in the NPRI and that "emissions were significantly higher than what was reported to NPRI, indicating an underestimation in reported emissions".

Using 'top-down' methodology, He et al. (2024) provides for a comparison between the measured and NPRI reported carbon. The results of He et al. (2024) show the value of inclusion of total carbon to the current NPRI reporting approach. The study showed significant under reporting as illustrated in the figure below:




1 (C) Estimated annual gaseous organic carbon emissions compared with the reported emissions converted to carbon mass units for the three highest emitting (both measured and reported) surface mining facilities (SML, SUN, and CNRL) (table S2), with percent differences. Annual emissions were estimated by using TC/NOx ratios, and error bars indicate the standard deviation of the derived TC/NOx ratios (with emissions derived as the TC/NOx ratio scaled by reported annual NOx emissions) (fig. S4 and supplementary materials).

As noted, the Action Plan for VOCs says 8h: “consider addition of total carbon” and the results of He et. al. 2024 would indicate this is necessary.

The He et al. (2025) data collection approach provides a ‘starting point’ for collection of air emissions from the Oil Sands facilities. Applying this method as a starting point, positions the Minister and NPRI with a means of assessing all ‘bottom-up data’ provided to NPRI in order to understand the substance gaps and their magnitude in reporting to NPRI.

**<u>Recommendation 4:</u> Collect NPRI information using “top-down” naphthenic acid emissions in order to inform an understanding emissions, and gaps, in reporting of emissions from Oil Sands processes.**

The Action Plan (issue 3) notes that the NPRI added naphthenic acids in 2020. While the Oil Sands facilities reported naphthenic acids in water and waste, the Action Plan states: “None of the OS mines (and none of the other facilities) reported releases of NAFCs to air.” (Action Plan, page 18).

Similar to the method of He et al. (2024), Moussa et. al. (2025) conducted top-down analysis through box flights of Suncor pond 2/3. Moussa et al. (2025) found:

*The results indicate that, despite the absence of NAFC air emissions in inventories, large quantities are emitted to the atmosphere, likely originating from surface photochemical and/or biodegradation processes. Emission rates across entire operations ranged from 3509 to 7286 kgh−1, translating to annual emissions of 1163−2660 tonnes from both primary and secondary sources.*

The report notes that the Oil Sands pond is the major source of the naphthenic acids:

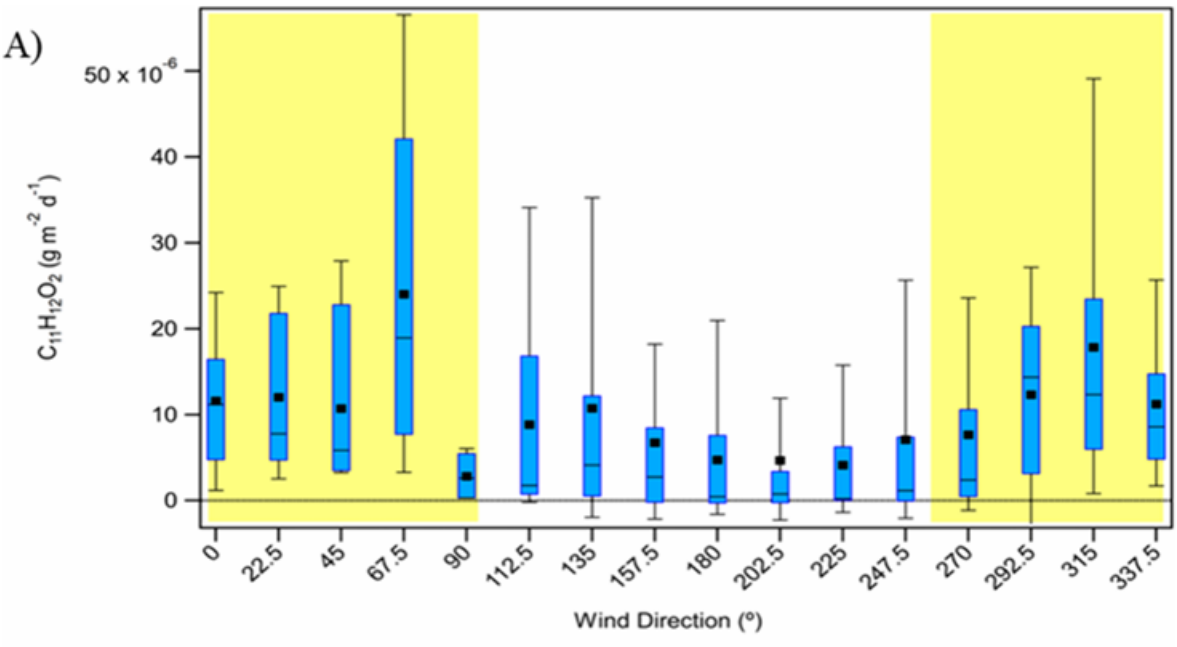



Figure 1A shows a typical flux for aC11 acid (C11H12O2) as a function of wind direction. Emissions were significantly elevated when the wind was from the direction of the pond (shaded region, Figure1A) indicative of **the pond being the major source of this acid** relative to other directions (off-pond; white region).

Thus, there is a major omission in the reporting of naphthenic acids by Oil Sands facilities.

Further, the finding of Moussa et al. (2025), at face value, points to a significant failing in the assumptions and emission factors used by the Oil Sands facilities in reporting to NPRI. In this respect the results support recommendation 1, that NPRI requires the development of a conceptual model of Oil Sands processes. 'Top-down' monitoring would validate any emission factors that are proposed and used in a conceptual model.

The Moussa et al. (2025) results can be used to generate emission factors to be used in a conceptual model to estimate NA emissions for all of the Oil Sands facilities. This approximation of NAs can be used to assess future reporting to NPRI.

**<u>Recommendation 5</u>: Require 'top-down' and 'bottom-up' monitoring for sulphur dioxide to develop an accurate understanding of emissions from Oil Sands processing.**

The Action Plan for sulphur dioxide proposes to investigate possible unknown sources, and development of emission factors. The Action Plan does not consider development of a quantitative conceptual model with monitoring to validate the model as part of NPRI reporting. Action Plan 11 notes the need to assess stack parameters broadly.

The Action Plan issue 7, for sulfur dioxide presents results from McLinden et al. (2021); the summary below presents information not covered in the summary and illustrates the value of a conceptual model

McLinden et al (2021) documents the variance in reporting to NPRI with SO2 measurements using, 'top-down' satellites to monitor SO2, bottom-Up continuous emission monitoring from stacks, and ground level monitoring.

The following figure from the paper illustrates the discrepancy in NPRI reporting vs monitoring.

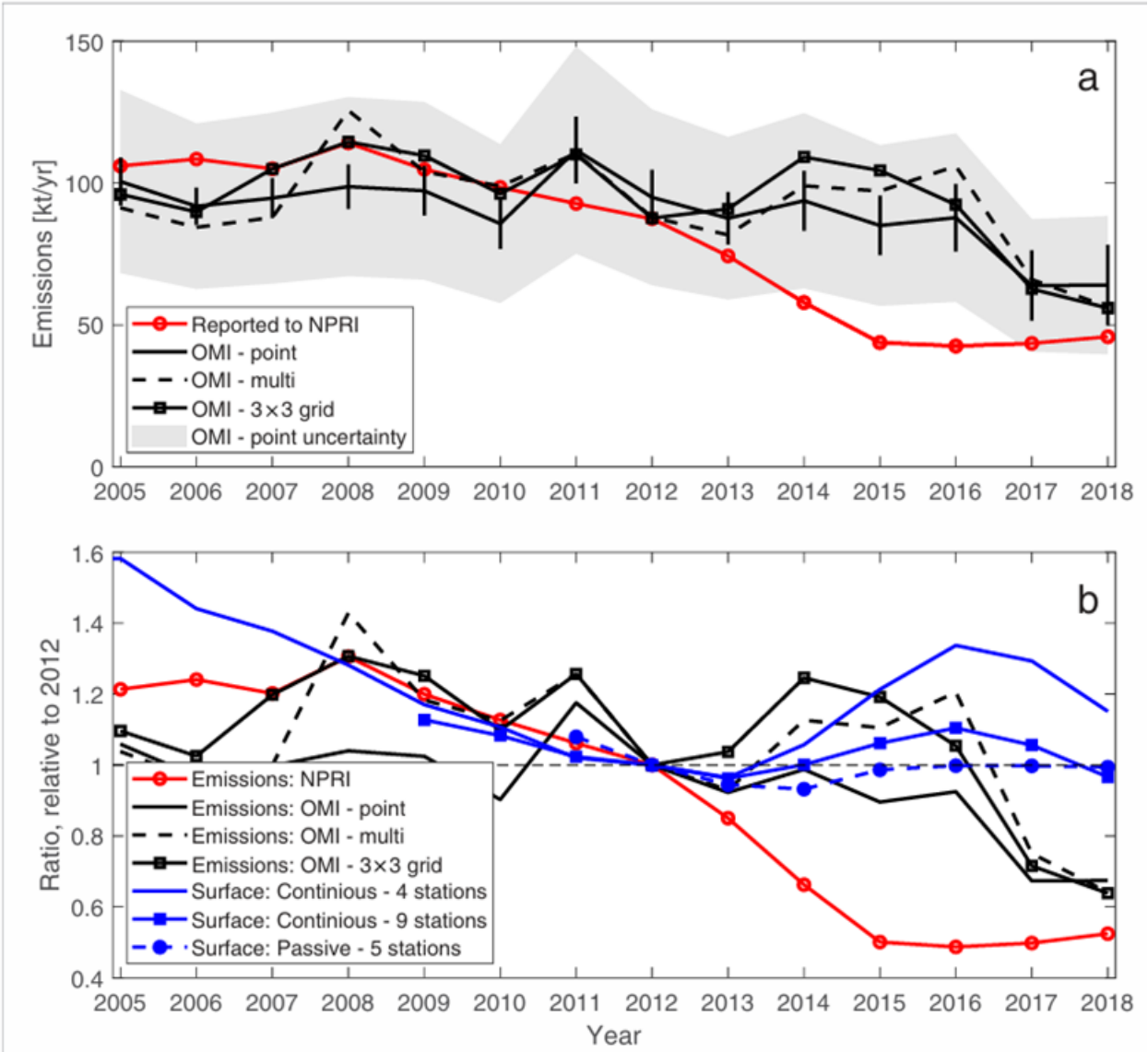



**Figure 4.** (a) Annual 3 yr running mean $SO_2$ emissions from OMI and NPRI. (For example, OMI data from 2008 to 2010 were used to determine OMI 2009 emissions whereas for NPRI 2009 emissions, 2008–2010 values were simply averaged.) The black lines represent three different variations of emissions algorithms applied to OMI, with the grey shading indicating the total estimated uncertainty for the point source method and the error bars the variability. (b) Variation of annual emissions from panel (a) and 3 yr mean surface concentrations (adapted from figure 2), all relative to their value in 2012.

In the figure the satellite emissions are the OMNI data. The paper notes that the spatial resolution of OMNI data is 13×24km2 at best, and more typically 15×35km2, and this is comparable to the entirety of the surface mining region.

The paper notes that: “From figure 4(a), up until 2013, OMI compares well with the reported emissions which suggests there are no significant systematic errors in the OMI emissions” (page 5).

The report concludes that:

> *The atmospheric observations considered here, collectively, suggest that* ***total SO2 emissions in the surface mining region did not decline in 2014 as suggested by the emission reports****, although there is mixed evidence that a more modest decline occurred around 2018. They also confirm that any sources of SO2 are limited to a small region in the immediate vicinity of the Suncor, SUN, or Syncrude-Mildred Lake, SML, upgraders.* ***While, at present, no satisfactory explanation exists that reconciles the reported and top-down emissions, it is nonetheless worth while exploring the potential explanations****. (page 8)*
>
> *We thus have three independent sources of information (satellite observations, surface concentration observation, and sulfur uptake in vegetation) which show no evidence of a decrease in SO2 loading within the 2014 2016 time period. (page 9)*

The explanation for the decrease in reporting of emissions is a mystery to the authors. The paper illustrates the value of top-down monitoring of emissions with comparison of bottom-up approaches, and these should inform a conceptual model.

Makar et al. (2024) 'Evaluation of GEM-MACH-Oil Sands' illustrates the value of bottom-up assessment of NPRI data, i.e., assessing what is submitted to NPRI with respect to SO2. This study supports the Action Plan issue 11 needs to assess stack parameters broadly.

Makar et. al. (2024) states:

> *As a result of the evaluation, several processes were identified as being of key importance in the OSR. A summary of key findings can be found in Section 9. Briefly, these include:*
>
> *(2)* ***Sulphur dioxide (SO2) in the OSR is emitted mostly from large stacks (95%),*** *and the accurate simulation of the height of large stack plumes is critical towards the model's ability to accurately estimate the concentrations of pollutants originating from those stacks. The evaluation established the importance of the quality of SO2 emissions data used to carry out simulations:* ***annual total SO2 emissions and typical operating conditions as submitted to the ECCC National Pollutant Release Inventory (NPRI) were insufficient to accurately simulate plume heights and hence surface SO2 concentrations. Better model performance was achieved*** *making use of measurements made at the stacks;* ***the use of time varying Continuous Emissions Monitoring System (CEMS) data,*** *obtained by ECCC from AEPA.* ***The differences between NPRI-submitted and CEMS observed data were sometimes quite large (e.g. 100$^{o}$C difference in stack temperatures).*** *SO2 simulation accuracy was improved with the use of a new plume rise algorithm incorporating the additional heat generated or lost through condensation and evaporation of combustion generated water, with a small positive bias of +27% achieved in the Run 4 simulations.*

The report shows the difference between what was submitted to NPRI and Continuous Emissions Monitoring System data for stack temperature (Makar et al. 2024, page 46)

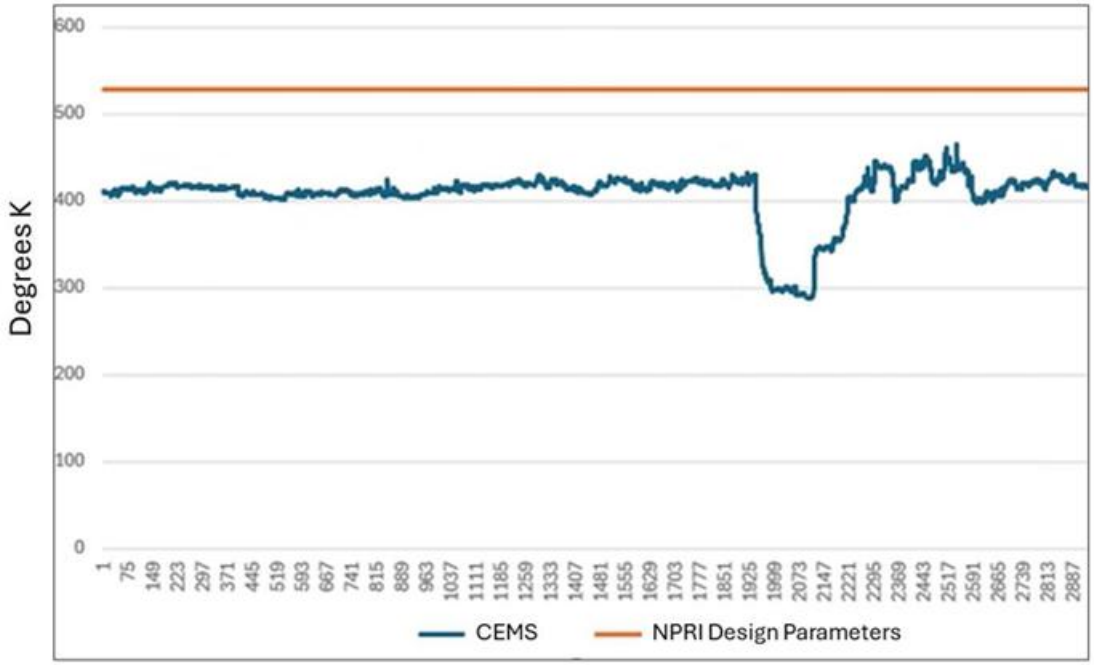



Figure 9.3.2. Comparison between NPRI-submitted "design parameters" stack temperature and CEMS 3 hourly-recorded stack temperature, Syncrude main stack.

Validation of information submitted to NPRI is critical. As demonstrated by this work, collecting emissions data can be used to validate inputs into the conceptual model.

**<u>Recommendation 6</u>: Require Oil Sands facilities to report mobile NOx emissions.**

The Action Plan issue 13 notes that the NPRI "does not currently require reporting of mobile sources, however, OS surface mine captive fleets made up 18-96% of facility total carbon monoxide emissions (Figure 27), 30-87% of NOx emissions (Figure 28) and 3-66% of PM2.5 emissions (Figure 29)".

McLinden et al. (2025) used satellite monitoring and a combination of two methods, one for point and one for area sources. An increase in emissions from about 55 to 80kt [NO2] yr 1 between 2005–2011 and a flat trend thereafter. Reported emissions were within 15% of reported emissions, consistent to within uncertainties. In an extension of this methodology, OMI observations were combined with reported point source emissions to derive the more uncertain emissions component from the large off-road mining fleet. These were found to make up about 60% of total NOx emissions, also consistent with reported emissions.

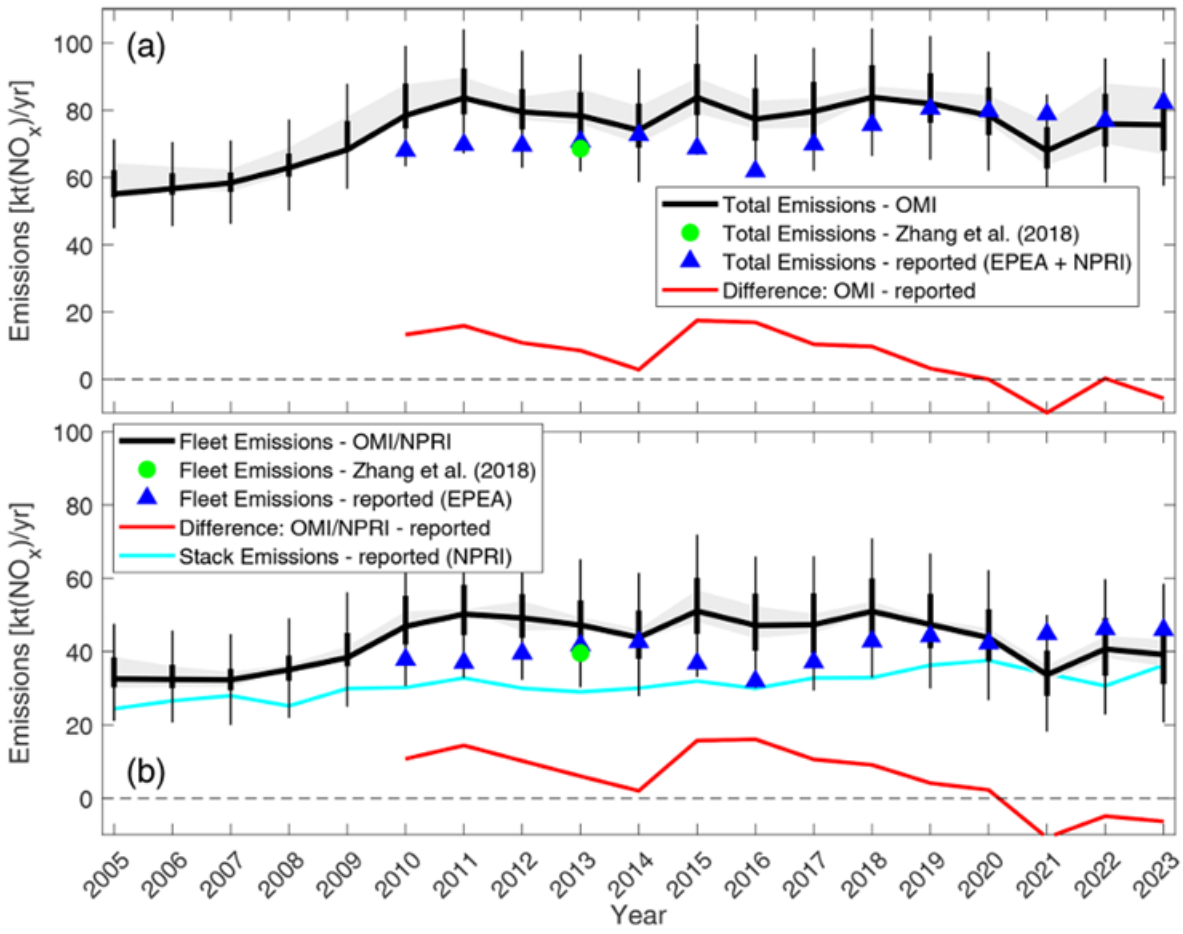



Figure 9. Comparison of reported and OMI-derived NOx emissions for (a) total and (b) fleet in the oil sands surface mining region. Thick error bars represent the random uncertainty, and thin error bars represent total (random and systematic) uncertainty. The shading indicates the variability among the various methods for deriving emissions (and is included in the total uncertainty).

'Top-down' monitoring in the McLinden et al. (2025) paper is effective and validates reporting. The paper provides a means of addressing the OSWG Action Plan objective to: Consider adding a requirement to report emissions from captive mine fleets.

The top-down method would be valuable in understanding the regional transportation and NOx emissions. There is significant transportation to and from the mine sites that is not presently reported and this should be included in the conceptual model. This would facilitate community knowledge about emissions from the Oil Sands sites.

**<u>Recommendation 7</u>: Require Oil Sands facilities to validate emission predictions, monitoring locations and report emissions of Polycyclic Aromatic Hydrocarbons (PAHs), Ammonia, Mercury (Hg) and PM.**

The Action Plan for PAHs, Ammonia, Hg and PM all support development of a quantitative conceptual model to better understand emissions from Oil Sands facilities.

The Action Plan issue 5 for PAHs recommends developing facility-specific emission factors for studied facilities (e.g., Suncor's Pond 2/3). Development of emission factors from Suncor ponds could be used for tailings ponds at other facilities and a conceptual model would facilitate understanding of variations observed among the fleet of facilities.

The Action Plan for Ammonia, Hg and PM are all relevant to support the development of a quantitative conceptual model.

The Action Plan notes the need for enforcement mechanisms that compel operators to report ammonia emissions from tailing ponds.  Development of emission factors for ammonia could be supported and validated through the development of a quantitative conceptual model.

The Action Plan issue 2B for Hg states: “Reported mercury emissions are inconsistent over time at facilities, between facilities and between federal and provincial inventories”. A conceptual model would support understanding of emissions and their variation, and support assigning mercury emissions to individual stacks.

Speciation of PM is necessary to understand toxic metal components, and human health impacts. A conceptual model would facilitate speciation of PM and the monitoring necessary to validate the model.

In particular, Hg and PM emissions have direct bearing on the health of ecosystems and people’s health.

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